REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
09/28/2015	Research Performance Report	July 2014 - June 2015

4. TITLE AND SUBTITLE
ATR Performance Estimation Seed Program

5a. CONTRACT NUMBER

5b. GRANT NUMBER
N00014-14-1-0589

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Cook, Daniel A.

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Georgia Tech Research Institute/ Sensors and Electromagnetic Applications Laboratory/ Smyrna, GA 30080

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
ONR Code 321
Office of Naval Research
875 N. Randolph St.
Arlington, VA 22203-1995

10. SPONSOR/MONITOR'S ACRONYM(S)
ONR

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Distribution Statement A: Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT
This project was a short-term multi-disciplinary and multi-institution collaboration whose purpose was to emplace the end-to-end workflow necessary to produce simulated MCM sonar data and demonstrate the impact of system, environmental, and target scattering effects on ATR detection/classification performance. The long-term goal is to use this framework as a foundation for providing accurate estimates of ATR performance in realistic settings and achieving better understanding the relative impact of the factors influencing ATR performance.

15. SUBJECT TERMS
sonar, mine countermeasures, MCM, automatic target recognition, ATR

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Daniel A. Cook
					19b. TELEPHONE NUMBER *(Include area code)*
U	U	U	UU	11	(404) 407-8886

Final Report: ATR Performance Estimation Seed Program

Daniel A. Cook
Georgia Tech Research Institute
Sensors and Electromagnetic Applications Laboratory
Smyrna, GA 30080
phone: (404) 407-8886 fax: (404) 407-7728 email: dan.cook@gtri.gatech.edu

Award Number: N00014-14-1-0589

LONG-TERM GOALS

This project was a short-term multi-disciplinary and multi-institution collaboration whose purpose was to emplace the end-to-end workflow necessary to produce simulated MCM sonar data and demonstrate the impact of system, environmental, and target scattering effects on ATR detection/classification performance. The long-term goal is to use this framework as a foundation for providing accurate estimates of ATR performance in realistic settings and achieving better understanding the relative impact of the factors influencing ATR performance. These performance estimates are expected to 1) better inform a priori plans and 2) facilitate updates to mission planning based on real-time or post-mission analysis.

OBJECTIVES

GTRI's specific role in this collaboration was to add realistic levels of environmental and processing noise to the data simulated by APL-UW. The noise modeling leveraged work funded by ONR Code 32 under awards N00014-12-1-0085 (GTRI) and N00014-12-1-0045 (ARL/PSU). The purpose of that work was predicting shadow contrast for sidescan sonar, requiring careful accounting of all forms of noise present in the imagery. Those models were used by the current effort to provide noise in the context of sonar sensing based on aspect-dependent target strength, or acoustic color.

APPROACH

Several groups of researchers came together for this short-term seed program to expand the Navy's efforts in performance prediction for MCM. The team included individuals from ARL/PSU, APL-UW, GTRI, and NSWC-PCD, whose areas of expertise include environmental modeling, target scattering, signal processing, and the development of ATR algorithms.

The goal of this seed program was to assemble and demonstrate an end-to-end methodology for estimating sonar ATR performance. The present consensus is to distinguish between 'imaging' and 'non-imaging' ATR. The former includes traditional sidescan sonar as well as HF and LF SAS, while the latter is aimed at acoustic-color information. Due to its limited scope and duration, the seed program emphasized achieving concrete goals and establishing connections between institutions as

opposed to in-depth research. Team discussions led to the following approach:

- APL-UW – Target scattering modeling through their TIER (Target in the Environment Response) program
- ARL/PSU – Environmental modeling leveraging their Seafloor Relief models
- ARL/PSU & GTRI – SNR modeling leveraging their Shadow Contrast model
- NSWC-PCD – Non-imaging ATR leveraging development on other ONR programs

As indicated above, GTRI built upon the shadow contrast research conducted under ONR Grant No. N00014-12-1-0085. Specifically, GTRI and ARL/PSU used this model to compute the various forms of noise experienced by an MCM sonar array and applied these noise terms to target models provided by APL-UW. The subsequent impact on ATR performance was assessed by NSWC-PCD.

WORK COMPLETED

This effort required collaboration across multiple teams and the integration of multiple models and analysis tools. GTRI facilitated the collaboration by establishing Sharepoint and secure FTP sites that allowed for the exchange of documents, data, and software. The exchange of information alone did not guarantee the success of this collaborative effort. In-person visits and frequent communications among institutions helped ensure that all parties understood and contributed to the conceptual framework linking together the various pieces of software used in the project. This facilitated the successful merging of target and environmental models, as well as the final training and testing of ATR algorithms. Now that this basic work flow has been established, the remaining tasks are to add modeled noise to the simulated data and carry out the ATR performance analysis.

Key achievements completed under this seed project are as follows:

- A program kickoff meeting was held, where the specific example problem and approach were determined.
- GTRI set up and hosted on-line collaborative resources for the program in the form of a Sharepoint web site and a secure FTP site.
- TIER model data from APL-UW was successfully shared among all institutions. GTRI and ARL/PSU added appropriate levels of noise to this data before it was used by NSWC-PCD to generate ATR results.
- GTRI hosted a final program meeting at its Cobb County Research Facility near Atlanta, GA on January 13-14, 2015.
- The team presented final results to ONR at the 2015 Unmanned Maritime Systems Technology review in Panama City, FL.

RESULTS

The results of the overall seed program, including contributions from all participating institutions, are documented in the proceedings of the 2015 ONR Unmanned Maritime Systems Technology review.

IMPACT/APPLICATIONS

Establishing the ability to estimate ATR performance will directly impact the MCM mission by providing the means for understanding how departures from ideal conditions impact the probability of detecting and correctly classifying mines.

TRANSITIONS

There are no technology transitions associated with this program.

RELATED PROJECTS

This grant leverages work previously funded by ONR Code 32 under awards N00014-12-1-0085 (GTRI) and N00014-12-1-0045 (ARL/PSU). Collaborative work at APL/UW is performed under awards N00014-07-G-0557/0032, “Acoustic Color of Mines and Mine-like Objects.”